upon these an advanced school modeled upon the German universities, but with a broader scope. In such a university the student in the colleges of liberal and fine arts has opportunity to elect work in applied science, and thus broaden his education. He feels the inspiring influence of scholarship and research, and thus gains enthusiasm for the elementary work because it leads to the heights. The student in applied knowledge is not restricted to subjects which concern his future profession, but he has the opportunity to pursue the humanities and the fine arts, and thus liberalize his education. He, too, feels the stimulus of the graduate school, and, if one of the elect, may become an investigator and thus further ameliorate the lot of mankind by new applications of science to life. The student in the graduate school, primarily concerned with creative scholarship, may supplement a deficient basal training by work in the liberal arts and in the schools of applied knowledge. Thus the college of liberal arts, of applied knowledge and of creative scholarship interlock. Each is stronger and can do the work peculiar to itself better than if alone. This combination university is the American university of the future, and this the University of Wisconsin must become if it is to be the peer of the great universities of the nation.

Wisconsin is among the state universities which have this opportunity open to them. Many of the states have divided their grants among several foundations, supporting at different localities, schools of liberal arts, of agriculture, of medicine and of mining. In Wisconsin there is only one institution which attempts to do university work. Public and private funds alike, which are to go to a university, should come to that institution. This statement does not imply lack of appreciation of the excellent and very important work done by the colleges of the state. May they continue to thrive; may they continue to have the support of the citizens of the state; for the many thousands of students that during the next half century are continuously to demand a college education in this state can not be accommodated in one institution. Collegiate work should be done at several centers within the state, but professional and university work is so expensive and the different schools and colleges so closely interlock, that the best opportunities can only be furnished in the various fields in the university. At a university of the first rank the opportunities for instruction in the fields strongly covered are superior to those which can be offered in an institution devoted to a single field. Wisconsin has fortunately escaped the fatal mistake of subdivision of its university effort. With the concentrated support of the state, public and private, there is no reason why the University of Wisconsin should not do in every line as high grade work as any in the country. My faith is such that I look forward with confidence to the future, with profound conviction that the breadth of vision, which has enabled this institution to grow from small beginnings to its present magnitude, will continue to guide the state, until a university is built as broad as human endeavor, as high as human aspiration.

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*THE UNIVERSITY OF MONTANA BIOLOGICAL STATION AND ITS WORK.*

THE University of Montana Biological Station at Bigfork, on Flathead Lake, opened its sixth annual session on July 18, the session lasting for five weeks. The circular giving announcement of the work for the season contains a number of new and choice original photographs, giving views of the region in which the station is located, including sketches of Flathead

Lake, the forests adjacent and the mountains in the vicinity.

This station was started in 1899 as an experiment, in a state as large as Ohio, Pennsylvania and Michigan combined, with less than two inhabitants per square mile, and with biological study at a low ebb in the schools of the state. It was intended to fill the double mission of affording a place where a few might find suitable place for carrying on study in a field comparatively unknown, and to supply a stimulus for the teachers and young naturalists, few of the latter having at that time yet appeared.

It is practically impossible for Montana people to attend eastern summer schools. One reason is on account of railroad expense. At present writing rates are advertised from Chicago to San Francisco and return by a different route at identically the same price as from Missoula to San Francisco and return, and at the same price as one way fare from Missoula to Chicago. For a few days in June one may get out of the state at a low fare. But Chicago students may visit Flathead Lake with little more expense for the return trip than return trip from Lewistown, Mont., by taking advantage of reduced rates. Moreover, the summer is the pleasant time for one to be in the mountains, and most people wish to stay during the pleasant season. Owing to the fact that railroads grant few privileges to Montana people, and Montana people wish to stay at home during the most pleasant portion of the year, it seemed advisable to look toward preparing a place at home where advantage could be taken of beautiful scenery, healthful recreation and balmy mountain air, in a locality where 'unknown' is written on half the objects that greet the eye.

The station has accomplished more than was anticipated at its inception five years ago. The small summer laboratory has long since ceased to accommodate the work of those in attendance. But, owing to the delightful weather prevailing at this season, it matters little whether the work be carried on indoors or not, unless table room and apparatus are needed. Students from twelve states have been present at different times, in addition to the many that have come from Montana. Already the schools of the state are feeling the effect in the work in zoology and botany, not only through the attendance of high school and grade teachers, but through the material which is collected and the printed matter prepared for distribution.

The printed matter thus far issued by the University of Montana, emanating from the work at Flathead Lake, covers 360 printed pages of close type, with 65 plates and 40 other illustrations, all from original photographs or drawings. In addition to this, numerous papers have appeared in various publications, greatly increasing the scope of the work.

The study of the birds of the Flathead Lake country has been carried on by P. M. Silloway, the well-known ornithologist. The first publication included 128 birds. This study has been carried on continuously for four seasons, usually from June until September. A second contribution increased the list to 137, which includes the summer residents and a few early fall migrants. This careful systematic work is especially valuable in making a good beginning in the study of the birds in a region not well known. The careful oological notes are full of interesting observations. Frequent references are made to calamities befalling old birds or their young. It is shown that birds occupy unfinished nests, which contain eggs. This may be due to the laziness or shiftlessness on the part of the mother, or to her inexperience, which

prevents rapid working, or to the destruction of a first nest. The finding of a nest of the willow thrush, which ordinarily builds close to the ground, six and one half feet up in a tree, will be of interest to students of animal intelligence, as illustrating the change of habit due to environment. The region in which the nests occur may overflow annually.

Among the interesting notes concerning the distribution of Montana birds, that of the occurrence of the varied thrush, *Hesperocichla nævia* (Gmel.), is of importance. This songster heretofore has not been reported east of the Coeur d'Alene Mountains in Montana. It was found in abundance at the head of Swan Lake, and by reliable observers in the neighborhood it was reported to be a permanent resident and one of the earliest in nidification. The olive-backed thrush, *Turdus ustulatus swainsonii* (Cab.), was found in numbers at the head of Flathead Lake, though in equally advantageous localities seventy miles farther south it was scarcely represented. At Selish, on the Jocko River, we noted the long-tailed chat, *Icteria virens longicauda* (Lawr.), abundant in numbers and in full song, though we were too early for the nesting season. A small colony of Holboell's grebe, *Colymbus holboellii* (Reinh.), was found nesting on Swan Lake, and several sets of eggs, in complements of three, four and five eggs, were taken. Specimens of pigeon hawk, *Falco columbarius* Linn., Richardson's Merlin, *Falco richardsonii* Ridgw., pygmy owl, *Glaucidium gnoma* Wagl., pileated woodpecker, *Ceophloeus pileatus* (Linn.) and the like were taken.

Principal Silloway is now pushing his ornithological investigations in other directions, to regions not visited by ornithologists, with the idea of later preparing a work on the birds of the state.

The biological station is favorably situated for carrying on work in plant ecology lines. This is due to the fact that within a radius of ten miles there are several different climates, giving rise to different plant formations. The west side of the valley at the head of Flathead Lake and the Mission valley at the south end of the lake have little rainfall, and a typical prairie vegetation is the result. Kalispell, situated in the prairie, has a rainfall of about sixteen inches per year. The east side of the valley has a greater precipitation and a forest formation results from this. Columbia Falls, situated at the base of the mountains on the east side of the valley, has a rainfall of a little over twenty-one inches per year. This town is only a short distance from Kalispell. The mountains near the station are very accessible, so that alpine conditions can be easily studied.

The botanical work done in the summer of 1902, by Harry N. Whitford, was entirely along forest ecology lines. A map was made comprising some 96 square miles, which are situated mostly in the forest formation, but reach into the edge of the prairie. Five well-defined plant societies were noted. These are distinctly related to the amount of water in the soil, and that in turn depends mainly on the topographic diversity. The hydrophytic societies are closely associated with a great amount of water in the soil. They are located along streams and around lakes, and have plants in them resembling very much those in similar situations in the eastern part of the United States.

The mesohydrophytic societies are usually adjacent to the meadows. Because the Engelmann spruce is the principal tree in these they are called the Engelmann spruce societies. Other trees associated with the spruce are the narrow-leafed cottonwood,

the aspen and the white birch. Bordering the Engelmann spruce stands are the western larch-Douglas spruce societies, so called because they are the predominating trees. The western larch-Douglas spruce type of a forest is decidedly mesophytic. In places where the soil contains nearly as much water as that in the spruce society, the silver pine (*Pinus monticola*), the lowland fir (*Abies grandis*) and the western arborvitæ are found. The lodge-pole pine is scattered all through the mesophytic area, sometimes forming almost pure stands in it. There is but little doubt that its presence in the region is due to the influence of forest fires. It is a tree that fruits well at an early age. This gives it a decided advantage over the other trees, because when frequent fires occur it is likely to be the only one with fruiting trees on the burned areas.

In places in the forest formations there are 'sandy pockets.' These are likely to have prairie vegetation. The absence of trees is probably due to the fact that the sand is not capable of holding the water sufficiently long to enable trees to get a start. Closely associated with these 'sandy pockets' and bordering the prairie formation are the bull pine-Douglas spruce societies. The bull pine (*Pinus ponderosa*) is the most xerophytic of the conifers and thus extends further out into the prairie region than any of the others.

A collection of the other plants of the region was made and their ecological distribution was noted. This collection has been deposited in the herbarium of the Field Columbian Museum at Chicago. Careful studies were not undertaken in the alpine regions, though in hasty trips made into these regions some problems were noted for future studies.

Extensive botanical collections were made in 1901. The station and the New York Botanical Garden worked conjointly during the season from June to September, Dr. D. T. MacDougal and Wilson P. Harris gathered nearly a thousand numbers, the latter looking particularly after the lichens and mosses. The lichens have been identified by Carolyn W. Harris, the mosses by Mrs. Elizabeth G. Britton. Duplicates are in the collections of the University of Montana and the New York Botanical Garden. A check list of lichens and mosses has been issued, giving twenty genera and sixty-seven species of lichens and nineteen genera and thirty-seven species of mosses, a total of thirty-nine genera and one hundred and four species.

The collection of flowering plants was gathered from territory much of which had never been visited by a botanist. The Mission range, fast becoming known on account of its grand scenery, was examined almost from end to end, a distance of nearly a hundred miles. The valleys at the base of the range are from 2,300 to 3,000 feet elevation, while the summits reach 10,000 feet. Excursions were made with pack horses into the Swan range, where specimens were gathered from snow-banks and the edge of glaciers. The alpine willow was found abundantly at 7,500 feet, the stunted trees, but a few inches in height, bearing flowers. Days were spent in crawling over steep mountains, with a heavy pack as an encumbrance, without road or trail, in search of specimens. The large series shows the result. Each number was taken in duplicate, one set being deposited in the herbarium at the New York Botanical Garden, the other at the University of Montana at Missoula. The identifications were by P. A. Rydberg, the well-known authority.

Some observations on the forests are worthy of notice. The alpine fir, *Abies lasiocarpa* (Hook.) Nutt., is found at a

low elevation, certainly as low as 3,000 feet. A few scattering trees are found on the banks of Swan River near the laboratory, while forests of this species may be seen at the upper end of Swan Lake. Here the trees are large enough for logging. A tree at 3,000 feet elevation aged 120 years was one third larger in diameter than one aged 200 years at 7,500 feet. The age of the largest trees at elevations about 7,500 feet is about 200 years.

The alpine pine, *Pinus albicaulis* Engelm., takes the place on the higher slopes of the yellow pine, *Pinus ponderosa* Laws., on the lower levels. The yellow pine is the pioneer, pushing out into the dry and unoccupied valleys, preparing the way for those species requiring more moisture. The alpine or white-barked pine can not tolerate moisture. It is practically absent in the protected amphitheaters at high elevations, leaving the alpine fir to hold full sway. The alpine pine takes the dry slopes, exposed to the sun, or the rocky ridges where soil is scanty and where existence is had by the severest struggle. It prefers a narrow and storm-swept ridge, or a dry and scorching slope, to the quiet, protected, but damp slope. Its gnarled, twisted and broken trunk is in marked contrast to the tall, tapering and stately alpine pine on the opposite side of a ridge, but a few rods away.

The lodge-pole pine, *Pinus murrayana* 'Oreg. Com.,' is a follower of other species. After the yellow pine, tamarack, or Douglas spruce has made a dense forest, making a rich and damp soil, a fire may clear the forest. Then the lodge-pole springs up, as thick as it can stand. The region adjacent to the laboratory shows this, where tall boles of monster tamaracks or yellow pines, amidst dense masses of younger lodge-poles, tell a mournful tale of magnificent forests but recently laid waste. Its ability to produce cones in a single year, coupled with the early maturity of the tree, six or seven years, gives the lodge-pole a firm hold on the soil. But it is its own destroyer, since it is intolerant of shade and may be squeezed out again by more hardy rivals. How many successions of species of forest trees there may have been will never be known. The evidence points to three in recent times: Yellow pine —Douglas spruce, tamarack and lodge-pole.

Extensive collections have been made of the fresh-water invertebrata of the western end of the state. By means of a canvas boat the soundings of mountain lakes have been made, and the life of the waters gathered for future study. These soundings and dredgings have been made during the past five summers, and much material and information has accumulated as the result. Lakes hitherto called bottomless are known definitely. Flathead Lake, covering more than three hundred square miles, has at no place a depth of more than three hundred feet. Enough work has been done to prove that at some seasons of the year the entomostraca have a decided diurnal or nocturnal movement, ascending to or toward the surface at night or during cloudy weather, descending when the sun shines. The depth to which they descend is from twenty-five to thirty feet. This corresponds almost exactly to the limit of vision when the white net is lowered into the clear and blue water. Again, for some unknown reason, certain species seek the surface during the hottest weather and brightest sunshine, when they may be dipped up with a tin-cup. *Daphnia thorata* Forbes was exceedingly abundant in 1901, when Forbes made his visit to the region, but at no time in the five years' collecting have we found it in large numbers. There is much room for study of the plankton of the region, and the waters at such varying

elevations, lakes at 3,000 feet and others at 9,000, offer a fine field for the limnobiologist. A few seasons of collecting during the summer whets the appetite for more extended study during the entire season.

A number of observations on the geology of the country have been made, suggesting fruitful fields for more extensive study. It has been shown conclusively that the northern end of the Mission range has been smoothed by the action of ice, a smaller mass from the south meeting a larger field from the north, the latter deflecting the former directly back—southward, but on the opposite side of the Mission range. It has been shown that the old bed of the Swan River was northward along the base of the Swan range, where it emptied into the Flathead near Kalispell, whereas it now empties into Flathead Lake at the northeastern corner.

Much of the surface geology of the Flathead and Mission valleys has been determined. It has been shown beyond doubt that the present outlet of Flathead Lake is comparatively new, and that the former outlet was through the western arm, near Dayton Creek. The present level is several hundred feet lower than the former level, the new outlet uncovering the rich valley at the head of the lake. The moraines at the foot of the lake and at other places in the Mission valley on the Flathead Indian Reservation have been brought to light and partially described. The moraine at the foot of the lake is four hundred and fifty feet high, and many miles long. It has not been followed westward. From the lake one rises by a steep wagon road to the summit, descending on the opposite side to a plain lower than the lake.

Incidentally shells have been gathered from various portions of the state. While few mollusks are to be expected from a region of rushing rivers and cold lakes, with small amount of lime in the water, yet the collection is very satisfactory and the number of species for the state is growing. The entire list for the state numbers but sixty species and varieties. Of these twenty-five have been collected west of the main range of the Rockies, forty-two from the eastern slope. Seven are found on both sides of the range. One new species and several new varieties have been described. No collecting for shells has been made along the Missouri or its tributaries except at Wibeaux (by Homer Squyer), on the extreme eastern border. The wide territory along the Missouri has not yet been touched.

In entomology extensive collections have been made, principally of the lepidoptera. Only the diurnals have been determined. These show that the butterflies of the northwest are in much confusion, and the study is beset with great difficulties. The life history of a large number is as yet 'unknown.' Indeed, this stares one in the face on almost all occasions, wherever he gathers material in the state. So interesting did the study of these airy insects become that a systematic report has been prepared and is now in press. This report will include photographs of all the specimens obtainable, with keys for identification. It is based on the collections of the writer; of Earl Douglas in the Ruby Mountain and the Madison range; of Professor R. A. Cooley, of Bozeman; of E. N. Brandegee, of Helena, and of the late C. A. Wiley, of Miles City. It lists about one hundred and twenty-five species. A few points may here be mentioned. *Parnassius smintheus* seems to be scarce at higher elevations in the western end of the state, but is often abundant at 4,000 feet, and has been taken on the shore of Flathead Lake, 2,900 feet. *Vanessa J. album* is

credited in all works as being everywhere scarce. It has been taken at Swan Lake by the hundreds, a dozen being taken in the net at a time. *Anosia plexippus* is scarce in the western slope. The milkweed has but lately been introduced along the railroads, and its numbers are increasing annually. But it is yet rare. Its mimic, *Basilarchia disippus,* has been taken at Gold Creek, on the Northern Pacific, where the last spike was driven, about fifty miles west from the summit of the range. It has not been taken further west. There is no doubt but that *Argynnis Edwardsi* and *Argynnis nevadensis* are synonyms, as shown by specimens from various localities, and by specimens in the Wiley collection and that of the writer, identified by Edwards himself. At Missoula butterflies were on the wing in 1903 as early as February 19, when *Vanessa californica* was taken. The cosmopolitan *Pyrameis cardui* is to be taken everywhere, while *Pyrameis atalanta* is very rare west of the range. As the state contains portions of four faunal areas, the Great Plains, the Hudsonian or Canadian, the Great Basin, and the Boreal, a diversified entomological life is to be expected. There are certainly many Pacific forms that have followed up the Columbia River and its tributaries. Indeed, it seems that the Pacific forms may have more invertebrate representatives in the western part of the state than those from the great basin. At any rate, many additional facts on distribution are recorded.

The dragon flies, numbering less than sixty species, about one half as many as are to be found in New York state, have been determined, and are in manuscript. One species, *Calopteryx yakima,* considered by Calvert to be synonymous with *C. æquabilis* from the eastern side, has been found at Flathead Lake. Years ago Hagen described the species from specimens taken at Lone Tree, near the Yakima River, Washington. He believed that it crossed the range from the east at some point 'above' (north of) Missoula. The finding of the species proves the soundness of his reasoning, and brings the species very close to the main range. It also confirms Calvert's view of the relationship between the eastern and western specimens. Further reference to this insect will be found in *Bulletin University of Montana,* Biological Series, No. 3.

Among the various collections that have been made at the station may be mentioned the splendid series of photographs. These have been taken at all altitudes from the level of Flathead Lake to the 10,000-foot summits. They show various geological and physiographical studies and formations of the mountain ranges, and serve to illustrate the changes that have taken place during ancient and recent times. Negatives have been made of the forests, trees and flowers, of large animals, birds and insects, illustrating phases of both animal and vegetable life. Many of these negatives are exceptionally good, and make remarkably good slides. When colored they show the views quite life-like. Altogether more than a thousand negatives have been secured. From these a book of photographs has been made. From these as samples it is possible to make selections, and slides will be made for those who may be able to make use of them. The book will be sent to responsible persons for examination with a view to selection of slides.

Some of the studies here given show the charm of a new field to those who have been privileged to visit it. Numerous problems yet awaiting solution could easily be proposed. With so many lakes close by, and others not far away, the daily, monthly and annual movements of entomostraca afford ample opportunity for the limnobiologist. The alpine heights, the vast for-

ests in the Lewis and Clarke reserve, the glaciated valley, the numerous mountain chains, the unknown animal and vegetable life, suggest numerous topics for the thoughtful student.

There is no reason why eastern friends should not make the laboratory a rendezvous during the summer. One can recreate to the fullest and yet have a definite object in view. It is impossible to visit the mountains and see them without some one of experience to help the visitor around. Vacation is gone before the wanderer 'hits the trail' he is seeking. His inexperience leads him to undertake things he can not do. Montana can not be seen from the car window. One must push out of the canyons. He is unwise who enters the pathless forests alone. They are too vast, the hills are on too large a scale, and the difficulties are too great to be entered hastily.

From the laboratory the collector may easily reach alpine heights, where grand scenery is spread before him. He may gather material for future study, undertake serious study indoors, more serious and more difficult study out of doors, and have the help and wisdom of those who have spent years in wandering in search of such places as many wish to visit and such specimens as many would gladly gather. The building is entirely inadequate to the demands of those attending, but it is believed that when the merits of the station are known and its opportunities fairly presented it will not lack for suitable quarters.

The summer session opened on July 18, and continues five weeks. The illustrated pamphlet, giving full information, will be sent to any one requesting it.

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## SCIENTIFIC BOOKS.

*The Evolution of Earth Structure with a Theory of Geomorphic Changes.* By T. Mellard Reade. New York, Longmans, Green & Co. 1903.

This work may be considered as a sequel to the well-known volume entitled 'The Origin of Mountain Ranges,' by the same author, which appeared in 1886. It is divided into three parts. The first of these treats of 'Geomorphic Changes' and deals with Regional Oscillation, the Relation of Continental Evolution to Mountain Building, Continental Growth and the Sub-Oceanic Configuration of the Earth's Crust. The second part deals with the 'Dynamics of Mountain Structure' and the experimental elucidation of the same, while the third part is made up chiefly of reprints of papers by the author on subjects allied to those just mentioned, which papers have appeared at various times and in different journals.

The author first cites numerous cases where there is distinct evidence of changes of level in the earth's crust, with concomitant bending of the strata composing the crust. He considers the principle of isostacy as quite inadequate to the explanation of these movements, since the mass of the solid earth involved in upward movement is entirely too great to be explained by any sedimentation which has taken place in the same period of time. These changes of level the author believes must be due to change in bulk of certain sections or portions of the earth's crust, without change of mass; the irregularities in the earth's surface, in fact, arising from differences in the specific gravities of the earth's crust and the underlying matter. These specific gravities are not stable, but are subject to slow changes consequent upon changes of temperature. A rise in temperature and increase in volume create a protuberance; a fall in temperature, on the other hand, gives rise to a depression, even to one of those profound abysses of the ocean aptly named 'deeps.' The cause of these secular variations in temperature, however, is not set forth, although in the mind of the author it seems to be in some way connected with chemical changes taking place in